Scientists shine new light on role of Earth's orbit in the fate of ancient ice sheets

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In a new study published today in the journal *Science*, the team from Cardiff University has been able to pinpoint exactly how the tilting and wobbling of the Earth as it orbits around the Sun has influenced the melting of ice sheets in the Northern Hemisphere over the past 2 million years or so.

Scientists have long been aware that the waxing and waning of massive Northern Hemisphere ice sheets results from changes in the geometry of Earth's orbit around the Sun.

There are two aspects of the Earth's geometry that can influence the melting of ice sheets: obliquity and precession.

Obliquity is the angle of the Earth's tilt as it travels around the Sun and is the reason why we have different seasons.

Precession is how the Earth wobbles as it rotates, much like a slightly off-center spinning top. The angle of this wobble means that sometimes the Northern Hemisphere is closest to the Sun and other times the Southern Hemisphere is closest, meaning that roughly every 10,000 years one hemisphere will have warmer summers compared to the other, before it switches.

Scientists have determined that over the past million years or so, the combined effects of obliquity and precession on the waxing and waning of Northern Hemisphere ice sheets has resulted, through complicated interactions within the climate system, in ice age cycles lasting approximately 100 thousand years.

However, before 1 million years ago, in a period known as the early Pleistocene, the duration of ice age cycles was controlled only by obliquity and these ice age cycles were almost exactly 41,000 years long.

For decades, scientists have been puzzled as to why precession did not play a more important part in driving ice age cycles during this period.

In their new study, the Cardiff University team reveal new evidence suggesting that precession did actually play a role during the early Pleistocene.

Their results show that more intense summers, driven by precession, have always caused Northern Hemisphere ice sheets to melt, but before 1 million years ago, these events were less devastating and did not lead to the complete collapse of ice sheets.

Lead author of the study Professor Stephen Barker, from Cardiff University's School of Earth and Environmental Sciences, says that "early Pleistocene ice sheets in the northern hemisphere were smaller than their more recent counterparts, and limited to higher latitudes where the effects of obliquity dominate over precession. This probably explains why it has taken so long for us to find evidence of precession forcing during early Pleistocene."

"These findings are the culmination of a major effort, involving more than 12 years of painstaking work in the laboratory to process nearly 10,000 samples and the development of a range of new analytical approaches. Thanks to this we can finally put to rest a long-standing problem in paleoclimatology and ultimately contribute to a better understanding of Earth's climate system."

"Improving our understanding of Earth's climate dynamics, even in the remote past, is crucial if we hope to predict changes over the next century and beyond. Ongoing changes may be manmade, but there's only one climate system and we need to understand it."

More information: Stephen Barker et al, Persistent influence of precession on northern ice sheet variability since the early Pleistocene, *Science* (2022). DOI: 10.1126/science.abm4033. www.science.org/doi/10.1126/science.abm4033

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